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Prevalence and Factors Associated with Severe Malaria in Children Under 5 Years of Age at Hoima Regional Referral Hospital, Western Uganda

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ABSTRACT

This study aimed to determine the prevalence and factors associated with severe malaria in children under five years of age at Hoima Regional Referral Hospital (HRRH) in western Uganda. A cross-sectional descriptive study was conducted in the pediatric ward of HRRH among 288 caregivers of children under five years admitted to the ward. Data were collected using a structured questionnaire, coded, entered, and analyzed using SPSS version 25. The majority of the children were female and above two years of age. Most caregivers were farmers, and many had no formal education. Among the 288 children admitted to the pediatric ward, 188 (65.3%) had severe malaria. Factors significantly associated with severe malaria included age and distance from home to the hospital. Children older than two years had a significantly higher likelihood of severe malaria ($P \leq 0.05$), with the odds being twice as high compared to those aged two years or younger. Additionally, children living five kilometers or more from the hospital had twice the odds of having severe malaria compared to those living within one kilometer. The odds increased fourfold for children residing between two and five kilometers from the hospital. The prevalence of severe malaria was high among children admitted to HRRH. Significant risk factors included being older than two years and living more than two kilometers from the health facility.

Keywords: Severe malaria, Children under five, Prevalence, Risk factors, Hoima Regional Referral Hospital

INTRODUCTION

Malaria is one of the most common and life-threatening tropical diseases worldwide [1]. It is caused by Plasmodium parasites, which are transmitted through the bite of an infected female Anopheles mosquito, primarily between evening and morning [2]. In humans, malaria is mainly caused by four species of Plasmodium: *Plasmodium falciparum*, *Plasmodium vivax*, *Plasmodium malariae*, and *Plasmodium ovale*. Among these, *Plasmodium falciparum* and *Plasmodium vivax* are the most prevalent [3,4]. The majority of malaria cases are concentrated in sub-Saharan Africa, where Plasmodium falciparum accounts for nearly all infections. It is the most virulent species, responsible for over 90% of malaria-related deaths worldwide, making it a significant public health concern [5]. Globally, malaria remains widespread in tropical regions, with approximately 3.4 billion people at risk each year, including 1.2 billion at high risk [6]. Despite being preventable and treatable, malaria continues to cause significant morbidity and mortality, particularly in resource-limited settings. An estimated 300–500 million people suffer from malaria annually, resulting in 1.5–2.7 million deaths, with sub-Saharan Africa contributing to over 80% of the global malaria mortality burden. Children under five years and pregnant women are the most vulnerable groups. Malaria is the leading cause of death in children under five, accounting for 77% of all malaria-related deaths globally [7]. In Africa, a child dies from malaria every minute. Severe malaria often results from delayed treatment and poor management of uncomplicated malaria [8]. It is defined as the presence of clinical and laboratory evidence of vital organ dysfunction. Nearly all malaria deaths are due to Plasmodium falciparum infection [9]. Although new drugs and vaccines have been introduced, malaria remains a major health challenge, and current strategies focus on prevention and control [10]. Uganda has one of the highest malaria burdens in sub-Saharan Africa, ranking third in Plasmodium falciparum infections and among the highest in malaria transmission rates globally [11]. Malaria transmission is stable and perennial in 90–

95% of the country. According to Uganda's Health Management Information System (HMIS), malaria accounted for 34% of outpatient visits and 28% of hospital admissions in 2015. Of these reported cases, 55% were laboratory-confirmed, increasing to 64% between July and December, showing an improvement in case management [12]. Efforts to reduce malaria transmission have been enhanced through interventions such as intermittent preventive treatment for pregnant women, distribution of long-lasting insecticide-treated nets (LLINs), and early diagnosis and treatment [4]. Despite these efforts, malaria remains the leading cause of death in Uganda, accounting for over 27% of all fatalities [13]. Uganda also has the highest malaria incidence worldwide, with 478 cases per 1,000 people annually [14]. In 2016, there were an estimated 216 million malaria cases globally, leading to 445,000 deaths, with 91% of these occurring in sub-Saharan Africa [15]. Children under five accounted for two-thirds of malaria-related deaths that year. According to Uganda's Ministry of Health, malaria accounts for 30–50% of outpatient visits, 15–20% of hospital admissions, and 19–14% of inpatient mortality [16]. Malaria-related mortality in children under five often exceeds 10%, increasing with disease severity. Severe malaria risk factors include coma, convulsions, acidosis, respiratory distress, hypoglycemia, hyperpyrexia, elevated lactate concentrations, and high levels of tumor necrosis factor [17]. Although substantial efforts have been made by the international community, Uganda's Ministry of Health, and healthcare services to expand malaria prevention, diagnostics, and treatment, severe malaria remains a significant public health problem. Many children under five continue to suffer from severe malaria, particularly those admitted to Hoima Regional Referral Hospital (HRRH). However, no previous studies have been conducted in the pediatric ward of HRRH to identify the risk factors associated with severe malaria. Therefore, this study aims to determine the prevalence and factors associated with severe malaria in children under five years at Hoima Regional Referral Hospital in the Bunyoro region.

METHODOLOGY

Study Design

This was a cross-sectional study in which quantitative data was collected.

Study Setting

The study was conducted in the pediatric ward of Hoima Regional Referral Hospital (HRRH), located approximately 180 km north of Mbarara, the largest city in the western region of Uganda. Hoima is situated about 297 km west of Kampala, Uganda's capital city, along a fully tarmacked two-lane highway. Hoima serves as the main town of the Bunyoro Kingdom in Hoima District. The district is bordered by Masindi and Buliisa Districts to the north, Kyankwanzi District to the east, and Kibaale District to the south, extending to the national boundary with the Democratic Republic of Congo in the west. HRRH is a public hospital funded by the Uganda Ministry of Health, and general healthcare services at the hospital are provided free of charge.

Study Population

The study population consisted of children under five years of age who were admitted to the pediatric ward of Hoima Regional Referral Hospital.

Inclusion Criteria

Children below five years of age admitted to the pediatric ward of Hoima Regional Referral Hospital.
Caregivers who consented to participate in the study.

Exclusion Criteria

Children below five years of age admitted to the pediatric ward but who died on admission.
Children admitted with severe malaria but older than five years of age.

Sample Size Determination

The sample size was determined using the Kish-Leslie formula:

$n = z^2p\,(1\text{-}p) / E^2$

Where:

- n = Estimated minimum sample size required
- P = 75% prevalence of severe malaria in children under five years in sub-Saharan Africa [15]
- Z = 1.96 (for a 95% Confidence Interval)
- E = Margin of error set at 5%

$n = 1.96^2 \times 0.75(1 - 0.75) / 0.05^2$

$n = 288$

Sampling Procedure

All children under five years of age who met the inclusion criteria were enrolled until the target sample size was reached.

Data Collection Procedure

Structured questionnaires were used to interview caregivers of children with severe malaria. The majority of the questions were a mix of open-ended and closed-ended formats. Data was collected on both caregivers and children with severe malaria. The questionnaire was designed to capture demographic information on caregivers and their children, along with healthcare system and household factors. Caregivers of children with severe malaria were interviewed on the day of admission or the next day, once the child's health had stabilized. Trained research assistants administered the questionnaires.

Data Analysis

Following data collection, the data was entered into SPSS version 20 for analysis. Each independent

variable was analyzed in a univariate form using tabular presentation. Subsequently, independent variables were compared with the dependent variable in a bivariate analysis. Finally, multivariate analysis was conducted to establish conclusions for this research.

Quality Control Measures

Study procedures were taught to selected research assistants. The accuracy, consistency, and completeness of completed questionnaires were evaluated on a daily basis. Pretesting of the questionnaires was also conducted to ensure reliability.

Ethical Considerations

Ethical approval was obtained from KIU IREC and HRRH. The study proposal was reviewed and approved by the HRRH Department of Pediatrics before commencement.

Confidentiality

The confidentiality of participants' information was ensured through the use of unique reference codes during data collection and analysis. Participants were assured of complete confidentiality regarding the information they provided.

Risks and Benefits

There were no painful procedures involved, except for treatment purposes. Children received treatment before participation in the research.

Limitations and Delimitations

1. The study was prone to selection bias as it was conducted at a health facility.
2. Non-cooperative respondents limited the scope of the study, and recall bias may have affected data accuracy.
3. The diversity of languages spoken by patients admitted to Hoima Regional Referral Hospital may have affected the accuracy of data collection.
4. Referral bias may have influenced the findings, as most children admitted to a referral hospital are likely to have severe malaria.

RESULTS

Socio-demographic findings

Table 1: Socio-demographic factors of the study participants

Variable	Frequency (n)	Percentage (%)
Age of the child		
Below 2 years	112	38.9
Above 2 years	176	61.1
Sex of a child		
Male	135	46.9
Female	153	53.1
Occupation of the caregiver		
Peasant farmer	201	69.8
Not a farmer	87	30.2
Education level of the caregiver		
None	127	44.1
Primary	107	37.2
Secondary	36	12.5
Tertiary	18	6.2

Prevalence of severe malaria among children under five years at HRRH

Table 2: Malaria status of children admitted at HRRH

Malaria diagnosis	Frequency (n)	Percentage (%)
Severe malaria Not severe un complicated malaria	188 100	65.3 34.7

Table 2 above shows that out of the 288 children admitted on pediatric ward at FRRH in the study, 188 (65.3%) had severe malaria.

Table 3: Results of Bivariate Analysis for Socio-demographic factors.

Variable	Severe n (%)	ncomplicated malaria n (%)	adjusted OR (95% CI)	P-value
Age of the child				
Above 2 years	79(70.5)	33(29.5)	2.1 (1.15-3.93)	**0.015**
Below 2 years	111 (63.1)	67 (26.9)	1.0	
Sex of a child				
Male	115 (85.2)	20(14.8)	1.0	
Female	73 (47.7)	80 (52.3)	3.8(0.82-17.54)	0.087
Occupation of the caregiver				
Peasant farmer	116 (57.7)	84 (42.3)	1.0	
Not a farmer	71 (81.6)	16 (18.4)	1.0 (0.49-2.08)	0.976
Education level of the caregiver				
None	81(63.8)	46(36.2)		
Primary	61(57.0)	46(43.0)	3.00(0.62-14.45)	0.172
Secondary	31(86.1)	5(13.9)	2.67(0.57-12.47)	0.214
Tertiary	15(83.3)	3(16.7)	2.68(0.53-13.54)	0.232

From the table 3 above only child's age and sex age had P-values <0.2 thus taken for the multivariate analysis.

Multivariate binary logistic regression of socio demographic factors associated with severe malaria among the study participants.

Table 4: Multivariate binary logistic regression of socio demographic factors associated with severe malaria among the study participants.

Variable	Adjusted OR (95% CI)	P-value
Age of the child		
Above 2 years	2.0 (1.07-3.74)	**0.030**
Below 2 years	1.0	
Sex of a child		
Female	1.84(0.97-3.50)	0.063
Male	1.0	

Following multivariate analysis, being a child above 2 years was significantly associated with severe malaria (P-value ≤ 0.05). The odds of having severe malaria were two-fold higher among children aged above 2 years as compared to those below 2 years.

Household factors associated with severe malaria in children under five years admitted on pediatric ward at HRRH

Table 5: Results of Bivariate Analysis for household factors

Variable	severe	Not severe	Un adjusted OR (95% CI)	P-value
	n (%)	n (%)		
Household size				
Below 5 in number	**80(80.0)**	**20(20.0)**	**3.4 (0.67-17.09)**	**0.142**
Above 5 in number	**108(57.4)**	**80(42.6)**	**1.0**	
Do you have mosquito nets at home				
Yes	37 (32.5)	77(67.5)	1.0	
No	121 (78.6)	33 (22.2)	1.5 (0.78-2.78)	0.233
Number of under five children at home				
One child	87 (56.1)	55 (43.9)	1.0	
2 or more children	101 (69.2)	45 (30.1)	1.7 (0.72-4.05)	0.219
Type of family				
Polygamous	143 (88.6)	21 (14.4)	1.00	
Monogamous	45 (36.3)	79 (63.7)	3.6 (0.82-15.89)	0.091
Materials used to wall of your house				
Wattle and mud Wood	97 (68.8)	44 (31.2)	1.00	
	43 (70.5)	18(29.5)	1.1 (0.39-3.25)	0.814
Sand and bricks	48 (55.8)	38 (44.2)	1.5 (0.47-4.91)	0.490

In the Bivariate analysis in table 5 above household size and type of family had P-values <0.2 thus taken for the multivariate analysis.

Multivariate binary logistic regression: Household factors associated with severe malaria among the study participants.

From table 6 below, both household size and type of family were not statistically significant in relation to severe malaria since both P-values > 0.05.

Table 6: Model one of multivariate binary logistic regression: Household factors associated with severe malaria among the study participants

Variable	Adjusted OR (95% CI)	P-value
Household size		
Below 5 in number	1.80(0.56-5.76)	0.320
Above 5 in number	1.00	
Type of family		
Polygamous	1.00	
Monogamous	3.00(0.62-14.45)	0.172

Health related factors associated with severe malaria in children under five years admitted on pediatric ward at HRRH.

From the table 7 below distance from home to the health facility and waiting time before taking a child to hospital had P-values <0.2 thus taken for the multivariate analysis.

Table 7: Results of Bivariate Analysis for Health-related factors

Severe Variable	Not severe	Unadjusted OR P-value n (%)	n (%)	(95% CI)
Community health facility yes no				
	103 (79.2)	27 (20.8)	1.0	
	85(53.4)	73 (46.6)	1.0 (0.36-2.85)	0.973
Distance from home to the health facility				
2-5 kilometers				
1 kilometer	60 (49.8)	63 (51.2)	4.0 (1.64-9.83)	0.002
> 5 kilometers	93 (76.9)	28 (23.1)	1.0	
	35 (91.3)	9 (8.7)	2.0 (1.02-3.93)	0.043
Means of transport to hospital				
Foot	66 (54.1)	56 (45.9)	1.0	
Bicycle	11 (40.7)	16 (59.3)	1.4 (0.29-6.88)	0.664
Boda boda	90(81.8)	20(18.2)	2.2(0.201-1.170)	0.207
Motor car	21(72.4)	8(27.6)	0.8 (0.278-2.409)	0.715
Medication given to child when identifies sickness				
no medication given	101(65.2)	54(34.8)	1.00	
local herbs	37(52.1)	34(47.9)	0.86 (0.32-2.34)	0.755
medication from drug shops/pharmacy	50(80.6)	12(19.4)	0.84 (0.29-2.42)	0.743
Waiting time before taking a child to hospital				
Within one day	79 (81.4)	18 (18.6)	1.6(0.126-1.00)	0.150
After one day	109 (57.1)	82 (42.9)	1.0	
Time taken to see a health worker at the hospital				
with 1 hour	53(71.3)	27(29.7)	0.63 (0.18-2.24)	0.472
with 2 hours	77(67.0)	38(33.0)	0.74 (0.45-1.24)	0.261
> 3 hours	58(62.4)	35(37.6)	1.00	
Getting all medication when at health facility				
Within one day	60(84.5)	11(15.5)	0.93 (0.53-1.62)	0.790
After one day	128(59.0)	89(31.0)	1.00	

Multivariate binary logistic regression: Health related factors associated with severe malaria among the study participants

According to table 8, distance of 2-5 kilometers from home to the hospital and distance of greater than 5 kilometers from home to the hospital were significantly associated with severe malaria. The odds of having severe malaria were two-fold higher among children within 5 kilometers or greater from home to the hospital as compared to distance of 1 kilometer from home to the hospital. In addition, the odds of having severe malaria were four-fold higher among children taking a distance of 2-5 kilometers from home to the hospital as compared to those taking distance of 1 kilometer from home to the hospital.

Table 8: Final model of multivariate binary logistic regression: Health related factors associated with severe malaria among the study participants.

Variable	Adjusted OR (95% CI)	P-value
e from home to the health facility		
2-5 kilometers	3.8 (1.51-9.56)	**0.005**
1 kilometer	1.0	
> 5 kilometers	2.1 (1.06-4.27)	**0.033**
g time before taking a child to hospital		
Within one day	1.1(0.37-2.98)	0.924
After one day	1.00	

DISCUSSION

Prevalence of Severe Malaria in Children Under Five Years of Age

This study found that the prevalence of severe malaria among children admitted to the pediatric ward at FRRH was 65.3%. In contrast, a study by Zgambo et al., [18] in Malawi reported an increase in the prevalence of severe malaria among children under five from 28% in 2012 to 33% in 2014. The prevalence observed in this study is significantly higher. According to UBOS, malaria contributes to 20-30% of all pediatric hospital admissions nationwide, and this study indicates that 65.3% of these cases are severe [19]. Consequently, if this trend continues, the national under-five malaria mortality rate may increase, potentially hindering Uganda's progress toward achieving the Sustainable Development Goals (SDGs).

Association Between Socio-Demographic Factors and Severe Malaria in Children Under Five Years of Age

This study identified a significant association between a child's age and the likelihood of severe malaria. Children older than two years had twice the odds of developing severe malaria compared to those under two years. This finding aligns with studies conducted in Uganda [20] and Malawi [18], both of which reported an increased risk of severe malaria among older children. This trend may be attributed to older children having more freedom to move outdoors at night, increasing their exposure to mosquito bites [21-26]. Additionally, Zgambo et al., [18] suggested that younger children are often covered well under mosquito nets as they share beds with their mothers, thereby reducing their exposure. However, this study's findings contrast with a study conducted in Rwanda by Nyirakanani et al., [22], which reported a higher prevalence of severe malaria among children aged 1 to 12 months compared to those aged 13 to 59 months. This discrepancy could be due to differences in the age groups considered in each study [24-27].

While various studies have demonstrated a significant association between household factors and severe malaria-such as household size, number of children under five years, family structure, electricity availability, and access to treated mosquito nets-this study found no significant association between household factors and severe malaria [24-28].

Association Between Health Facility Factors and Severe Malaria in Children Under Five Years of Age

This study identified a significant association between the distance to a health facility and severe malaria. Children residing five or more kilometers from a hospital had twice the odds of developing severe malaria compared to those living within one kilometer. Furthermore, children who lived 2-5 kilometers away had four times the odds of developing severe malaria compared to those within one kilometer of a hospital. These findings are consistent with a study in the Asikuma-Odoben-Brakwa District, Ghana, which reported that longer distances to health facilities encourage reliance on traditional medicine, allowing mild malaria cases to progress to severe forms [23]. The strong association between distance and severe malaria

underscores the role of healthcare accessibility in malaria outcomes. Caregivers' treatment choices are often influenced by the availability and accessibility of healthcare facilities, making longer distances a critical risk factor for severe malaria.

CONCLUSION

In conclusion, this study highlights a high prevalence of severe malaria among children admitted to the pediatric ward at FRRH. The key factors significantly associated with severe malaria were a child's age and the distance from home to a healthcare facility. Older children (above two years) and those residing more than two kilometers from a hospital were at a higher risk of developing severe malaria.

Recommendations

- Mothers and caregivers should be particularly vigilant about the health of children older than two years, as they are at increased risk of severe malaria.
- The government and healthcare policymakers should prioritize establishing health centers closer to communities to improve accessibility.
- Academicians, researchers, and health organizations should conduct further studies to explore additional factors influencing severe malaria in children under five years of age.

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